

## Unit 3.3 Exam – Part 1

AP Biology

2017 - 2018

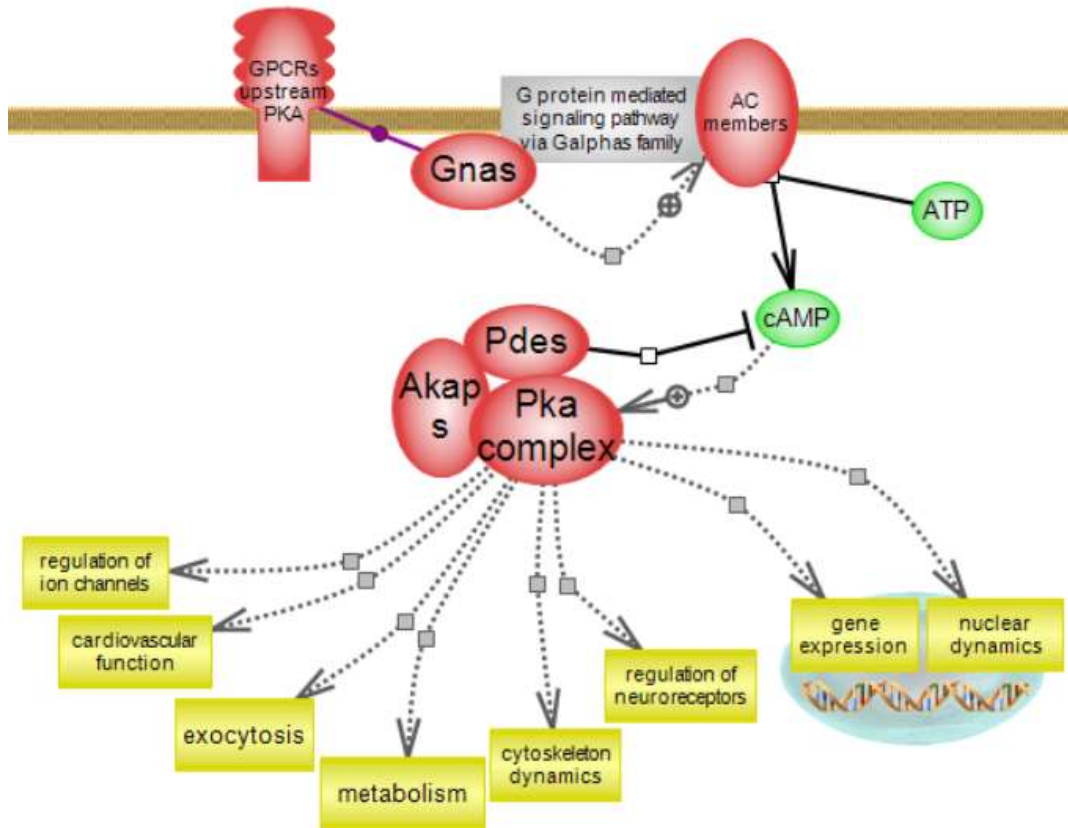
This portion of the exam consists of 9 multiple choice questions & 1 calculation

Each question values 1 point for a total of 10 points.

Ligand & Characteristics	Receptor & Characteristics	Response
Estradiol – hydrophobic/non-polar lipid hormone	Nuclear receptor. Receptor is coded by a gene activated around puberty by other sex hormones.	Stimulates expression of female sex characteristics.
Testosterone – hydrophobic/non-polar lipid hormone	Nuclear receptor. Receptor is coded by a gene activated around puberty by other sex hormones.	Stimulates expression of male sex characteristics.
Insulin – hydrophilic/polar protein hormone	Membrane receptor. Receptor is expressed if no mutation in coding gene is present.	Stimulates polymerization of glucose into glycogen.
Glucagon – hydrophilic/polar protein hormone	Membrane receptor. Receptor is expressed if no mutation in coding gene is present.	Stimulates hydrolysis of glycogen into glucose.

The table above provides characteristics of ligand molecules and receptor molecules.

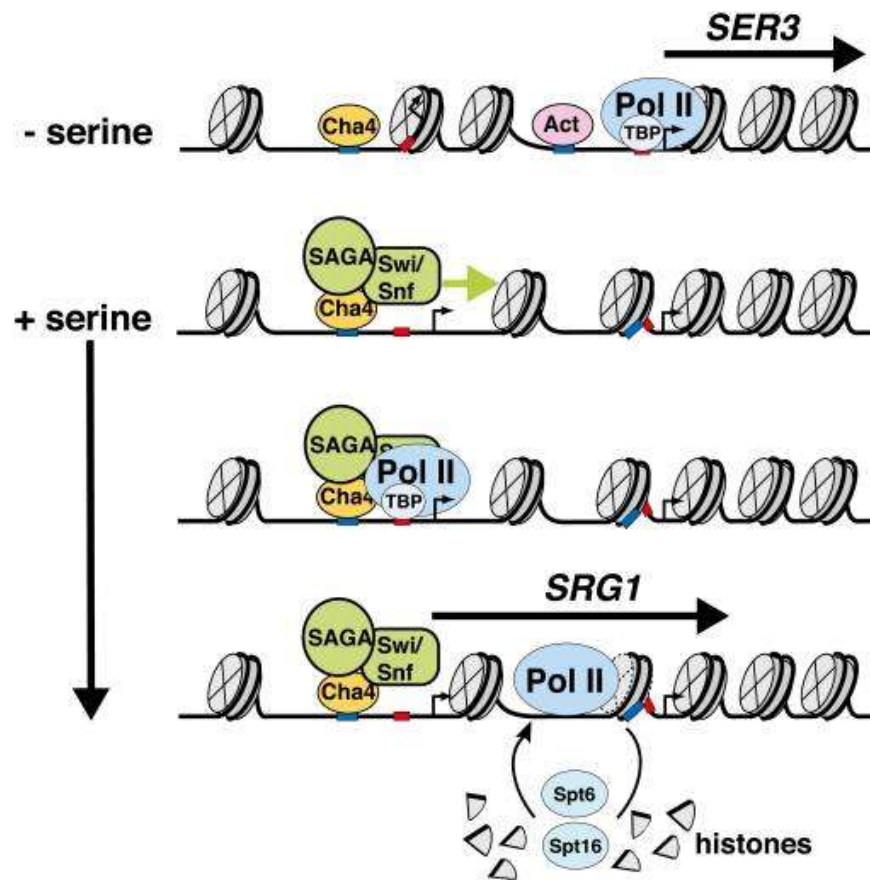
- Which of the following most accurately describes one of the above as a signal transduction pathway that would function normally?
  - The estradiol pathway at or after the onset of puberty.
  - The testosterone pathway prior to the onset of puberty.
  - The insulin pathway when the receptor coding gene has been properly spliced.
  - The glucagon pathway when there are consistently high concentrations of proteasomes.
- Which choice below shows a correct sequence of events in a nerve signaling pathway?
  - Sensory neurons → Integration → Efferent Neurons → Interneurons
  - Efferent neurons → Sensory neurons → Interneurons → Integration
  - Interneurons → Integration → Efferent neurons → Sensory neurons
  - Sensory neurons → Interneurons → Integration → Efferent neurons



The signaling pathway shown above shows numerous signaling molecules including cAMP, Pka complex (a Kinase) & AC members (Adenylyl Cyclases).

3. If a mutation in AC members were to decrease their functionality, which of the following is a likely consequence?

- The G-protein would become non-functional.
- The rate of exocytosis would decrease.
- The regulation of neuroreceptors would be unchanged.
- An over-production of cAMP would occur.



**FIGURE 1: SERINE METABOLISM PATHWAY IN PLANTS & FUNGI**

In plants & some fungi, the *SER3* gene encodes an enzyme, which catalyzes the first step in the biosynthesis of the amino acid serine from a carbohydrate. *SER3* expression is negatively regulated by serine availability by a mechanism that involves the expression of *SRG1*, a type of ncRNA.

High serine levels induce transcription of *SRG1*, and its expression is associated with histone acetylation & repositioning in a region that overlaps the *SER3* promoter, which consequently represses *SER3*. The histones are acetylated ahead of the transcribing RNA polymerase (Pol II) and de-acetylated after passage of Pol II by Spt6 and Spt16.

Expression of *SRG1* is activated by the transcription factor *Cha4* by recruiting the SAGA and Swi/Snf coactivator complexes to the *SRG1* promoter, events also required for *SER3* repression.

4. Which gene regulation strategy modeled in the serine metabolism pathway represents a difference among prokaryotes & eukaryotes?

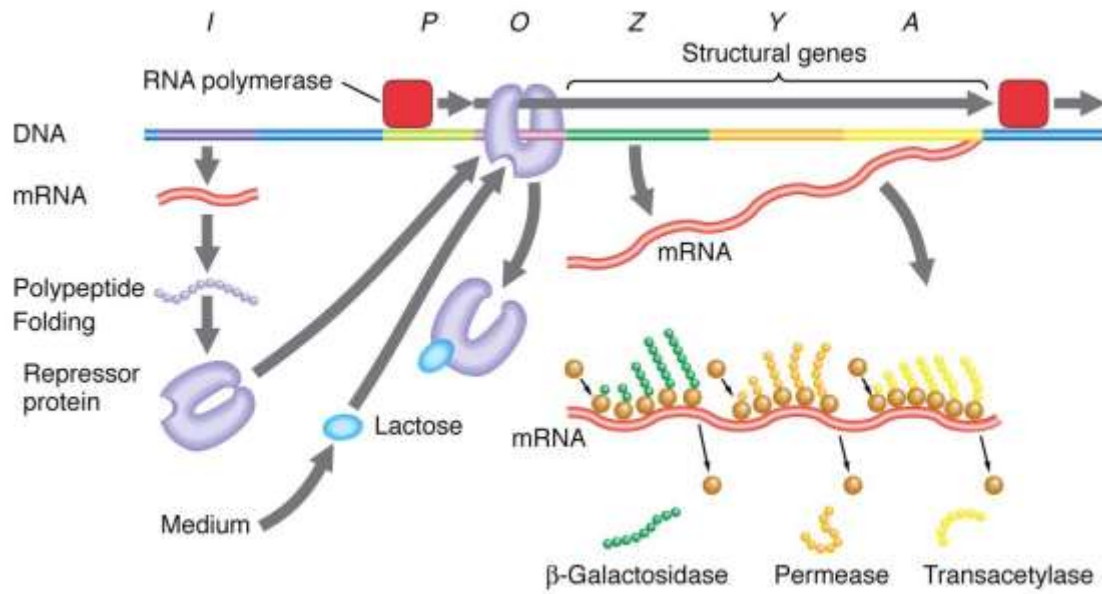
- a. The ability to modify chromatin structure
- b. The ability to use RNA polymerase to transcribe multiple genes.
- c. The use of operons to regulate plant serine metabolism.
- d. Changing gene expression in response to varying levels of nutrients.

5. Which statement most accurately predicts the role of the *SRG1* product in gene expression?

- a. The *SRG1* product role is to catalyze the biosynthesis of serine so the *SER3* gene must also catalyze the biosynthesis of serine.
- b. The *SRG1* product role is to degrade mRNA so its product must act on mRNA that encodes serine biosynthesis enzymes.
- c. The *SRG1* product role is to upregulate mRNA so its product must act on mRNA that encodes RNA polymerase.
- d. The *SRG1* product role is to produce mRNA so its product must act on mRNA that encodes serine histone acetylation enzymes.

6. The function of *Cha4* in the serine metabolism pathway is best described as

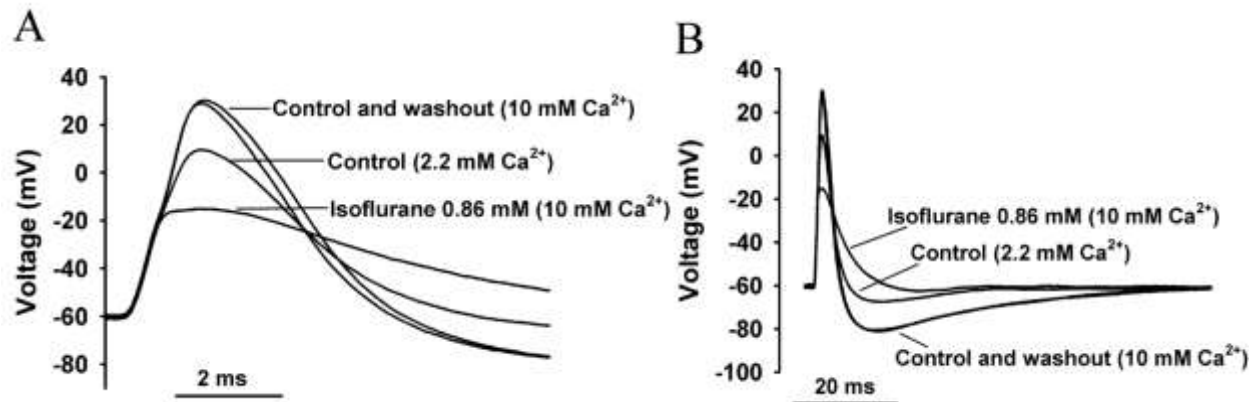
- a. a gene activator or inhibitor depending on its environmental conditions.
- b. a ncRNA activator in the absence of serine.
- c. a ligand for a transduction pathway not shown.
- d. a proteasome essential for serine metabolism.



7. Suppose a microbiologist becomes proficient with a technique that allows her to move DNA sequences within the Lac Operon depicted above. If she moves the promoter for the *lac* operon to the region between the *beta galactosidase* gene and the *permease* gene, which of the following would be likely? Assume lactose is present.

- Beta galactosidase will be produced.
- RNA polymerase will no longer transcribe permease.
- The operon will no longer be inducible.
- Three structural genes will no longer be expressed.

Questions 8-10



The figures above represent the action potentials for experiments on rat nerve cell axons, testing the effects of the anesthetic isoflurane on rat consciousness under general anesthesia. Figures A and B are the same data shown under different time scales (2ms and 20ms, respectively).

8. A logical inference that can be made from the data would be

- Isoflurane functions to decrease consciousness by increasing neurotransmitter release with its added calcium.
- The control and washout trial aimed to evidence any changes in action potentials due to increased calcium levels alone.
- The mice nerve cells in the control group showed no depolarization, and thus the data would be considered unreliable.
- Isoflurane cannot decrease consciousness without 10mM Ca<sup>2+</sup>.

9. Isoflurane is a general anesthetic thought to act on several different ion channels that lead to an unconscious state and paralysis. In most cases, patients under this type of anesthesia also require an oxygen mask to provide adequate oxygen but heart rate generally remains stable without any medical assistance. Which of the following is an appropriate question to be addressed concerning effects of general anesthetics on ion channels?

- Are the Na<sup>+</sup> channels blocked while Ca<sup>2+</sup> channels are stimulated?
- Does is selectively block Na<sup>+</sup> channels of sensory neurons?
- Are the ion channels of different chemical composition in the nervous system & heart?
- What maximum isoflurane concentration can be administered to trigger changes in heart rate?

10. Calculate the difference in voltage at the point of hyperpolarization among the Isoflurane treatment & the control and washout treatment. Provide your answer as the absolute value of the voltage difference.